

What is Claimed is:

1. A method of forming a hollow stepped shaft, characterized in that it comprises the steps of:

holding an upper and a lower part axially of a solid rod-like blank with an upper and a lower die, respectively, which have a stepped recess of large diameter in a region thereof where they are opposed to each other;

compressing the blank from both its axially opposite sides with an upper and a lower punch each of which is smaller in diameter than the blank and at least one of which is moving, thereby extruding the blank so that an axial hollow is formed therein about its axis in each of said upper and lower parts and that a portion of the blank opposed to said stepped recess of large diameter expands in diameter and deforms into said recess while leaving a solid plug-like portion between said punches; and thereafter

further compressively moving one of said punches to shear said solid plug-like portion and force it out of the blank,

whereby said blank is formed with a stepped portion of large diameter by radially expanding deformation in a region intermediate between its opposed ends or at one of these ends and with a continuous axial hollow about its axis, thereby forming a hollow stepped shaft.

2. A method of forming a hollow stepped shaft as set forth in claim 1, characterized in that said solid rod-like blank is loaded into said upper and lower dies which are in a closed die-fastened state and thereafter extrusion of the blank is performed with said punches.

3. A method of forming a hollow stepped shaft as set forth in claim 1, characterized in that said solid rod-like blank is loaded into said upper and lower dies which are in an open die-unfastened state and thereafter extrusion of the blank are performed with said punches while said dies are being closed

and fastened.

4. A method of forming a hollow stepped shaft as set forth in claim any one of claims 1 to 3, characterized in that the method further comprises the step wherein a hollow stepped shaft so formed as aforesaid is further formed in another die set to impart an additional outer contour thereto.

5. A method of forming a hollow stepped shaft as set forth in claim 4, characterized in that in said further step, said additional outer contour is imparted to the hollow stepped shaft with a mandrel inserted therein.

6. A method of forming a hollow stepped shaft, characterized in that it comprises the steps of:

supporting a solid rod-like blank at its first end with a bearer while its outer periphery is bound and extruding the blank about its axis from its second end with a first punch so as to form an axial hollow therein about the axis; and

extruding the hollow blank forwards and backwards with a second and a third punch so as to form the hollow blank in a region thereof intermediate between the first and second ends or at one of these ends with a stepped portion enlarged in both diameter and thickness while simultaneously making the blank longer.

7. A method of forming a hollow stepped shaft as set forth in claim 6, characterized in that the blank is extruded about its axis with the first punch to form the axial hollow while the bearer supporting the blank at the first end is resiliently supported by a hydraulic or pneumatic means.

8. A method of forming a hollow stepped shaft as set forth in claim 6, characterized in that the blank is extruded about its axis to form the axial hollow by rapidly advancing the first punch while the bearer supporting the blank at its first end

is allowed to move back slowly by a servo mechanism.

9. A method of forming a hollow stepped shaft, characterized in that it comprises the steps of:

extruding a solid rod-like blank with its outer periphery bound, from its opposite sides about its axis with a first and a second punch so as to form a pair of axial hollows in its two axial parts, respectively, while leaving a solid plug-like portion of the blank between these two hollows;

compressively moving one of the punches to shear said solid plug-like portion out of the blank whereby a single continuous axial hollow is formed from said axial hollows; and

extruding the hollow blank forwards and backwards with a third and a fourth punch so as to form the hollow blank in a region thereof intermediate between its opposite ends or at one of these ends with a stepped portion enlarged in both diameter and thickness while simultaneously making the blank longer.

10. A method of forming a hollow stepped shaft as set forth in claim 9, characterized in that said solid plug-like portion is sheared out of the blank by one of said first and second punches after the other punch is extracted and while the blank is supported resiliently at one of its ends by a hydraulic or pneumatic means.

11. A method of forming a hollow stepped shaft as set forth in claim 9, characterized in that said solid plug-like portion is sheared out of the blank by extracting one of said first and second punches and thereafter rapidly advancing the other punch while one end of the blank is moved back slowly by a servo mechanism.

12. A method of forming a hollow stepped shaft as set forth in claims 6 to 11, characterized in that solid rod-like blank is made of carbon steel and is hollowed at a rate of reduction in area of 25 % wherein the depth of the axial hollow in the blank

is set at a value that is 5 times or more larger than the inner diameter which is a criterion of stable working in a cold forging and its boring regions are heated at a temperature ranging between a room temperature and 700°C.

13. A method of forming a hollow stepped shaft as set forth in claims 6 to 11, characterized in that the hollow stepped shaft has those regions in axial portions where serrations are formed having a tooth form applied thereto by fitting or press-and-shrink fitting, which are further drawn or made smaller in diameter by multistage pressure forming with upper punches and lower dies.

14. A hollow stepped shaft formed by a method as set forth in any one of claims 1 to 11.